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CANADIAN AIRCREW SEA WATER SURVIVAL
1952 - 1987

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ABSTRACT

A 36-year retrospective study of all Canadian military aircraft has been conducted. There have been 55 aircraft accidents where aircrew or passengers have landed in the sea. One hundred and fifty-eight personnel have been involved with 68 fatalities, an overall survival rate of 57%. Survivors were rescued in under 15 minutes in 40% of cases, the remainder were rescued in under three hours. The longest time spent in a life raft was 2 hours and 45 minutes. Seventy percent of aircrew had less than 15 seconds warning of impending water immersion. There were five cases where crew and passengers probably died from a combination of cold, drowning and cardiac arrhythmias. Immersion suits were worn in only six accidents and in two of these, leakage was reported. Aircrew who have received training in water survival, underwater escape trainers, who are strong swimmers or sports divers, have a better chance of survival. Therefore, it is strongly recommended that aircrew, particularly helicopter pilots flying over water, should receive underwater escape training.

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INTRODUCTION

In 1982, Brooks and Rowe completed a review of the survival of Canadian Forces (CF) aircrew ditching, parachuting or ejecting into both fresh and sea water, including the penetration of ice in frozen rivers and lakes (1). For the purpose of that study, all these accidents were classified as water accidents. The authors originally had intended to examine all the water accidents back to 1952, when the Royal Canadian Air Force (RCAF) introduced its first ejection seats into service, in order to complete a continuous 30-year retrospective study. However, apart from Smiley's report (4) much information prior to 1962 appeared to have been lost or destroyed about 1968 during the integration of the Services and the coincident amalgamation of the RCAF Institute of Aviation Medicine (IAM) and the Defence and Civil Institute of Environmental Medicine (DCIEM). Therefore, a decision was made at that time to review accidents only back to 1962.

Five years have now passed since that review took place, and further effort has been made to search for more evidence on the mislaid water accident files. Additional old RCAFIAM documents have been found and the old card index at National Defence Headquarters, Directorate of Flight Safety in Ottawa has again been searched, and the author is satisfied that he has now, at least, recorded virtually all the RCAF sea water entries back to 1952. A search for Royal Canadian Navy accidents prior to 1962 was abandoned because it appeared that many official records were lost or destroyed. This paper is a review of all sea water accidents for the RCAF from 1952 to 1968 and for the CF (after integration of the three Canadian Services) from 1968 to 1987, a total period of 36 years.

GENERAL FINDINGS

From 1 January 1952 until 31 December 1987, there have been 55 accidents in which aircrew have, through some form of aircraft mishap, landed in the sea. During this time, the RCAF have flown over 17 million hours, thus a sea water accident can be expected once for every 300,000 flying hours, or alternatively, aircrew who have an accident have approximately a 1-in-20 chance of it being in seawater. The case of two Sabres lost on the same day in a two-plane mission and the case of two Tutor jet trainers that collided in mid-air have each been considered as one accident. Another accident in which a Sabre pilot crashed into the frozen sea off Prince Edward Island has not been included because the ice was not penetrated.

Over the 36-year period, there have been 16 types of CF aircraft in accidents involving sea water immersion. The number of accidents for each type are shown in Table 1. Jet and propeller-driven aircraft with the most accidents are, respectively, the Sabre with 13 cases and the Tracker with 3

cases. The Sea King with 10 cases, is the only helicopter type to be crashed or ditched into sea water. There were two accidents in which an individual crewman fell from a serviceable airborne aircraft into the sea and were lost. These two personnel are included in total personnel involved; the crew members of only the helicopter are also included; in the case of the Argus aircraft, it was quite impossible to guess how many crew were onboard.

There have been 68 fatalities out of a total of 161 personnel involved in this series of sea water accidents, giving a survival rate of 57%. All accidents are briefly tabulated by aircraft type, date, number of personnel who died and who survived, accident site and cause factors. For ease of reference, each case is given a number (Tables 2, 3 & 4).

In propeller driven aircraft, there were six accidents in which everyone perished, three accidents in which everyone survived and three accidents in which there were both survivors and fatalities. In the jet aircraft accidents there were 18 all-fatal accidents, 14 non-fatal accidents, and one accident in which the navigator did not survive, but the pilot did. All survived in seven of the ten helicopter accidents; there were survivors and fatalities in each of the remaining three accidents. This is tabulated in Table 5.

Accident Site. Crashes and planned ditchings at sea have occurred throughout Western Europe and North America. There have been accidents off both coasts of Canada, as far north as Prince Rupert, British Columbia, and Frobisher Bay, Labrador, and off the coast of Washington and Oregon States, USA (Pacific Ocean), the West Indies, England (North Sea), Scotland (Irish Sea), the Netherlands, Denmark, Spain (Atlantic Ocean), and finally Sardinia and Italy (Mediterranean Sea). There has been no general pattern of fatalities related to accident sites.

Night Accidents. There have been eight accidents (Table 6) that occurred in darkness as follows:

- a. an Expeditor crew that flew into precipitation and icing which made the radio bearings unreliable (Case 3). The pilot became lost, ran out of fuel and, with about 10 to 15 minutes' warning, ditched the aircraft off Finale Fegure in Italy. It appears that the crew of five had time to prepare for the ditching, so there were no fatalities.
- b. a Tracker which, following several missed approaches to HMCS Bonaventure, clipped the wing of a parked aircraft and was unable to land back on the aircraft carrier (Case 9). After flying for 40 minutes to burn off fuel, a planned and successful ditching took place in the sea midway between Puerto Rico and Jamaica with no fatalities.
- c. an Argus on an ASW mission which suddenly, without warning, crashed into the ocean (Case 11). Darkness could have contri-

buted to the cause of the accident, but did not contribute to the fact that there were no survivors, as this was a non-survivable accident.

d,e,f. three jet aircraft that crashed into the ocean at night without warning. In the first of these, a Canuck pilot and navigator experienced a double engine flame out during a training flight off Campbell River, British Columbia, and ejected (Case 37). Only the pilot was able to be rescued. Darkness and cold weather could have contributed to the fact that the navigator was never found. Another Canuck pilot and navigator on a cross country navigation training flight became disoriented on approach to Comox before dawn and disappeared suddenly, into the Georgia Straits, British Columbia (Case 38). A Silver Star pilot crashed into the sea, also off the Vancouver coastline likely because he mis-set his altimeter (Case 40). Darkness could have contributed to the cause of the last 2 accidents, but not to the fatalities since both were non-survivable.

g,h. two Sea Kings that probably flew straight into the sea off Bermuda. In Case 14, all of the four crew might have been able to escape if the accident had occurred in the daylight. They were likely disoriented or distracted. Only the navigator and observer survived. In Case 18, the crew became disoriented while carrying out a night ASW exercise off Bermuda. Because no bodies were found, it is only possible to speculate what happened from the vague testimony of the surviving navigator. The two pilots, likely received fatal injuries, but could have drowned after impact. The observer also perished possibly through injuries, but possibly through drowning. It could be postulated that, if the accident had occurred during daylight and his injuries were not too severe, he might have been able to escape from the aircraft after impact. The accident in the cabin of the helicopter was survivable because the navigator made a remarkable escape from approximately 20 feet submerged in 21°C sea water, perforating his tympanic membranes in the procedure. Factors that likely contributed to his survival was that he had received Dunker training and he had some diving experience.

In these eight night accidents, five were considered survivable (Cases 3,9,14,18,37), however there were fatalities in three accidents (Cases 14,18,37) and it is postulated that darkness contributed to these fatalities.

Time to and Method of Rescue. Of the 31 accidents in which there were survivors (tabulated in Table 6), rescue was reported to have been completed in under 15 minutes for 12 (38%). It was accomplished in less than one hour for 6 (19%), and in under three hours for 4 (13%).

There were two cases (7%) where a crew member mysteriously fell out of an airborne aircraft: one from the cargo door of a Sea King helicopter

into the open ocean below, off Halifax, Nova Scotia (Case 13); and the other likely from the photographic hatch of an Argus over the Bay of Fundy (Case 12). Times of rescue were not annotated in these boards of inquiry presumably because the remaining crew conducted a search immediately after discovering that someone was missing.

There were two deliberate water ditchings (7%) of Sea King helicopters which were subsequently flown off the water again under their own power with no need for rescue of the crew (Cases 16 and 21).

Lastly, there were five accidents (16%) for which rescue times were not recorded:

- a. the Expedito off the coast of Italy (Case 3);
- b. a Canso that did a water loop in Knox Bay, British Columbia when the pilot attempted a down wind landing in deteriorating weather, 19 personnel were rescued, but two crew and one passenger died (Case 4);
- c. a Sabre that crashed into the North Sea offshore the English coast at Wells following loss of control, the pilot waded ashore (Case 30);
- d. a Sabre that developed engine problems, the pilot ejected into the Atlantic Ocean 10 miles east of Valencia, Spain (Case 33);
- e. and lastly, a Canuck that had an engine failure over Vancouver, the pilot ejected into the Georgia Straits, British Columbia (Case 36).

Since no comments were made in these boards, it is likely that rescue occurred relatively quickly. It can therefore be stated, with reasonable confidence, that all survivors were rescued in under three hours.

Method of Rescue

The methods of rescue reported were as follows: by boat (11), by helicopter (9), by submarine (1) and wading ashore (1). As previously mentioned, the crews of two ditched helicopters flown from the water under their own power did not require rescue, two crewmen were unable to be found after falling to their deaths from airborne aircraft, and there are five cases of unknown rescue method (Table 6).

Could the Survival Rate have been Changed?

In order to answer this question, all of the 31 accidents with at least one fatality, were reviewed. In five of these cases, there may have been a possibility of survival.

- a. a Canso that waterlooped with 19 personnel onboard: two crew and one passenger drowned (Case 4). Rescue times were not mentioned in the written inquiry and there is insufficient evidence to draw a conclusion.
- b. the Sabre pilot who, after running out of fuel, ejected successfully into Miramichi Bay, New Brunswick and manually inflated his life preserver (Case 31). His body was found eight days later; autopsy revealed that he had received a skull fracture and ultimately drowned. Again, although the evidence in the board of inquiry is not conclusive, it is possible that had he been found quickly following the ejection (when it is likely that he was still alive) he may not have drowned, and possibly could have survived his head injuries.
- c. another Sabre pilot who successfully ejected, inflated his life preserver and landed in Miramichi Bay (Case 34). He was also found drowned. No rescue times were reported and, again, there is little written evidence from which to draw a conclusion.
- d. a third Sabre pilot who was completing a full card air test over Tracadie, New Brunswick (Case 35). At 15,000 feet he entered a spin and ejected. Fishermen close by saw him land in the water with a full parachute and heard him yell once, but then he disappeared. It is postulated that he died either of an arrhythmia induced by sudden entry into cold water, or by drowning perhaps because he was semi-conscious from a head injury. His life-preserver did not have an automatic inflation device. In this case, it appears that only immediate rescue could have saved the pilot.
- e. a fourth Sabre pilot who, after his aircraft ran out of fuel, crashed into the North Sea off Flamborough Head (Case 24). No trace of him was ever found. Again, there was very little recorded detail about this accident, which occurred in 1952, and no conclusion could be reached.

In summary, there is little evidence to suggest that quicker rescue both could be achieved practically and would have changed the events in these accidents.

IMPENDING KNOWLEDGE OF THE ACCIDENT

It is estimated that for 38 (69%) of the 55 accidents the crew were aware of the impending accident less than a mere 15 seconds before it occurred. This is illustrated graphically in Table 7 and tabulated in Table 6. There were fatalities in 60% (23 accidents) of this group. The crew had up to one minute warning in nine other accidents (16%), and, 44% (4) of these accidents resulted in fatalities. The crew had warning up to five minutes before the accident in five cases (9%), of which 60% (3) resulted in fatalities. The crew had up to 15 minutes warning in one

accident (2%) and 40 minutes warning in another, neither case involving fatalities. Lastly, there was one fatal accident for which it was impossible to estimate the warning time. It does appear that survivability is decreased if the warning time is under 5 minutes.

HYPOTHERMIA

Sea water temperatures were reported in only 19 cases (Table 6 and 8) as follows: 0°C (1), 1-5°C (2), 5-10°C (1), 10-15°C (4), 15-20°C (5) and above 20°C (6). Weather and sea water conditions were reported in 27 cases and were generally good. This probably relates to the fact that in peacetime, the urgency to fly in deteriorating weather is not as imperative. The coldest conditions were -1°C off Halifax (Case 13), and 10°C, 25-knot winds and 20-foot waves off the Spanish coast during February (Case 33). The weather conditions have generally not been severe considering the potential.

There were five cases (four Sabres, one Canuck) for which it can be postulated that the aircrew died from drowning, hypothermia and/or some form of cardiac arrhythmia/arrest as a result of being suddenly immersed in cold water. None of the crews were wearing immersion suits during these accidents and water temperatures were not recorded by the investigators. The five cases are:

- a. a Sabre pilot who died in a mid-air collision at 8,000 feet over the North Sea in April 1952 (Case 23). The board of inquiry concluded that the pilot had died from "exposure in cold water";
- b. the Sabre pilot who, after his aircraft was out of fuel, ejected successfully into Miramichi Bay in December 1953 (Case 31). As previously mentioned, his body was found eight days later with an inflated lifepreserver and an autopsy revealed that he had suffered a skull fracture.
- c. the pilot of another Sabre which developed engine problems on a training flight out of Chatham, New Brunswick in April 1960 (Case 34). He also ejected into Miramichi Bay. The board noted that his life preserver was inflated and that he had died "probably from simple exposure";
- d. yet another Sabre pilot who, following entry into an unrecoverable spin, ejected off Tracadie, New Brunswick, into the sea (Case 35). He was heard by fishermen close by to cry out as he entered the water. Only his helmet was ever found and it was presumed by the board of inquiry that he had received a blow to the head possibly from the canopy, rendering him mildly-concussed. It is also possible that he suffered from an arrhythmia, or that he simply drowned, noting that there was no automatic inflation device on his life preserver;
- e. the navigator of a Canuck that had a double flame out over

Campbell River (Case 37). The crew ejected into the Georgia Straits, British Columbia in December. The pilot was rescued "in excellent condition despite the weather and despite the fact that his hands were very cold". He did suffer a head injury during the rescue phase, knocking his head on the side of the Royal Canadian Mounted Police rescue launch. The navigator was never found and likely drowned as a result of the choppy seas and the cold weather.

There were seven accidents in which aircrew suffered from some degree of hypothermia, had rescue been slower, they likely would have perished. They are:

- a. a Sabre that flamed out off Hunstanton in July 1952 (Case 25). The pilot, with loss of electric power and boost control at 7,500 feet, decided to eject into the North Sea. He was submerged for 4-5 seconds and surfaced entangled in his parachute shroud lines. The board noted that his dinghy did not inflate and "if rescue had not been effected immediately by the crew of a USAF Amphibian, the pilot would have died of exposure because he was too tired and cold to assist rescuers";
- b. an accident in September off the coast of British Columbia in which two pilots onboard a Silver Star successfully ejected into the Georgia Straits after a mid-air collision (Case 41). The second aircraft landed successfully. One pilot was dragged and entangled in his parachute for 30 minutes before rescue and "suffered from mild shock" which, for this review, has been interpreted as cold shock.
- c. a Voodoo on a training air intercept mission which pitched up and could not be recovered (Case 44). Both the pilot and navigator ejected into the Pacific Ocean 150 miles southwest of Portland, Oregon in 12.5°C sea water. They had both decided not to wear an immersion suit even though there was a requirement to do so (3). They were rescued after 90 minutes in their respective one-man life rafts, by the crew of a US Coastguard helicopter. They were both cold and noted the flare gun was difficult to operate with gloved hands that were cold, wet and slippery;
- d. a Starfighter on a low level reconnaissance mission which had a devastating bird strike (Case 50). The pilot ejected off the coast of Denmark. He had great difficulty inflating his life preserver and nearly drowned in the process. Being a strong swimmer, he elected to try to swim to the shore in 16°C sea water. He was not wearing an immersion suit and was rescued from the sea 23 minutes later. His core temperature measured at the time of rescue was 34.7°C. He was actively rewarmed (technique not known) for 45 minutes, when his temperature had returned to 37.5°C. This was the only case of true clinical hypothermia and also the only one where active treatment by rewarming was necessary;

- e. a Freedom Fighter in which the pilot lost control and ejected into the Gulf of Mexico in November 1987 (Case 54). There was some delay in the hoisting procedure during rescue and he was dunked several times in the process. He felt very cold when he was brought ashore 90 minutes later;
- f. a Sea King helicopter on a crew training mission 30 miles south-east of Halifax, Nova Scotia (Case 19) ditched due to mechanical problems. This is the only one of the seven cases where the crew were wearing immersion suits; however, the suits leaked several litres of water. The sea water temperature was 2.2°C. All of the crew were very cold and had numb hands.
- g. a Sea King helicopter which flew into the sea off Bermuda, both pilots and the observer were never found, but the navigator made a miraculous escape at night from 20 feet submerged (Case 14). He was reported to have been cold and understandably shaken.

IMMERSION SUITS

It is surprising that statistically during the past 36 years of peacetime operations, immersion suits have not contributed very much to survival. However, this may be anomalous for the following reason. Immersion suits were worn during only six out of the total of 55 accidents (Table 9). Suits were worn in only one of seven accidents in which crew were reported to be suffering from some degree of cold. In that case (Case 19), all of the suits leaked and it is questionable if they were of much benefit. They were worn in two non-survivable accidents -- that of the Starfighter pilot who became disoriented during an air combat manoeuvre and tactical break and ejected out of the performance envelope of the seat into the sea off Bodo, Norway (Case 52), and of the Sea King observer who fell to his death from the cargo hatch (Case 13). The suits were also not used during the Sea King accident in which the crew ditched the helicopter in the ocean 45 miles east of Halifax in October 1980, but were able to take off from the water again (Case 21). In the Sea King mishap off the Dutch coast in 13-15°C water (Case 20), four crew were wearing suits and one passenger was not. The suits worked satisfactorily for the crew, however, if the rescue time had been greater than six hours, the unprotected passenger's life would have been threatened. In the case of the Sea King ditching in 11°C water 20 miles off Halifax Harbour (Case 22), one of the immersion suits worn by the three crew members leaked.

LIFE PRESERVERS

Life preservers were definitely worn, or were concluded to have been worn in view of operational requirements in 36 cases (Table 9).

Observations on the Lifepreserver That Functioned Satisfactorily. The life preservers were successfully inflated (manually or automatically) during the accident, or confirmed to be serviceable following the accident in 24 (67%) of these cases.

However, in this group there were some adverse comments such as "no one saw whether the passengers knew how to fit them correctly, nor was one for every passenger", in the Canso accident (Case 4). The Sabre pilot who ejected into the North Sea off Cromer (Case 29) had difficulty climbing into his life raft with his life preserver inflated.

There were two Sabre accidents where the pilots' bodies were found dead still in their inflated life jackets eight days and several hours after their respective accidents (Cases 31 and 34). They had both ejected into the Miramichi Bay off New Brunswick and neither wore an immersion suit. One pilot likely died from a combination of drowning, head injury, cardiac arrhythmia and immersion in cold water. (Water temperature is normally less than 10°C in this area in December.) The inquiry concluded that the second pilot died of "simple exposure" and in retrospect, as discussed previously, again the cause was likely a combination of drowning and hypothermia. Neither pilot had a dinghy available and neither had face shields on their life preservers. This further supports the current belief that survivors inhale water and drown from waves washed over their face quite soon after immersion in spite of having good inflated life preservers.

In Case 42, the Voodoo accident off the Georgia Straits, British Columbia, the pilot had difficulty in locating the small toggle to inflate the life preserver during parachute descent; and, lastly, in Case 44, the life preservers were judged in a post-accident examination to be unable to last the normal five-year life cycle.

However, in this group of 24 accidents, there are three notable accidents in which the life preserver worked particularly well. The pilot of a Starfighter who ejected off the air weapons range in Deccimomannu, Sardinia into the Mediterranean Sea (Case 49). He ejected at an altitude of 24,000 feet, but neglected initiating his emergency oxygen before initiating the ejection. He then deployed the parachute too early and consequently received a blow to the head from the parachute drogue plate. Experiencing a combination of hypoxia and concussion, he failed to disconnect the airlock fastener on the seat kit, consequently, during water entry 19 minutes later, the maritime lanyard parted and he lost his life raft and seat kit contents. Despite an abnormally large weight of publications in his calf pockets, he was kept afloat by his life preserver until rescued, at which point he was exhausted and on the point of drowning. He thought that he had been in the water 1½ hours but, in fact, he had been in the water for only 10 minutes. He was given artificial respiration both in the rescue boat and later ashore. He survived, but developed a reactive gastroenteritis and aspiration pneumonia as a result of sea water ingestion.

The value of and need for the Conax auto-inflation device introduced into service on the CF-6316 life preserver in 1975 is illustrated by two cases. The first where, during an airshow, the pilots of two Tutor aircraft (Case 45) collided over Seattle, Washington. They entered the sea immediately after ejection; their life preservers inflated automatically,

and they were rescued successfully after about 5 minutes. Similarly, in the second case, a Starfighter pilot ejected at low level, 450 knots during a bombing run at the Terschelling Range in Holland and experienced water entry and parachute opening simultaneously (Case 53). He suffered mild concussion and a dislocated shoulder, but his life preserver inflated automatically and held him afloat until rescued about five minutes later.

Lifepreserver Not Recovered After the Accident. The life preserver was lost with the crew and/or aircraft in six accidents, only one of them (Case 35) was considered survivable.

- a. a Mustang pilot who, flying low level, became disoriented and suddenly plunged into the sea (Case 7);
- b. the Argus crew who, also flying a low level in an ASW training mission, suddenly plunged into the sea (Case 11). Maritime patrol aircrew normally do not wear their life preservers on a routine basis, but carry them stowed by their seats;
- c. the Voodoo crew who were practising for the Vancouver airshow and crashed into the Georgia Straits. The navigator was never found although the pilot's body was later recovered and the life preserver was found to be serviceable (Case 43);
- d. the Hornet pilot who suddenly entered the sea off Malpeque Bay, Prince Edward Island, at a high speed (Case 55);
- e. the Sea King crewman who fell to his death from an airborne helicopter into deep water off Halifax, Nova Scotia (Case 13);
- f. the Sabre pilot who ejected after being unable to recover from a spin during a full card air test over the sea off New Brunswick (Case 35). As previously mentioned, at 15,000 feet he entered an unrecoverable spin and ejected. He descended into the water in his parachute, yelled once (heard and seen by fishermen close by) and then disappeared. His body was never found, although his helmet was recovered. He may have been hit by the canopy and mildly concussed. The toggle on the type of life preserver that he used has always been difficult to locate and grasp, particularly with cold and wet gloved hands. It appears that he was therefore unable to inflate his life preserver on descent and drowned on water entry. Further investigation revealed that it took 37 seconds for a mentally-prepared uninjured man in his harness to unbuckle, clear the leg straps and inflate his life preserver. In this accident, an automatic inflation device would probably have saved his life.

Unsatisfactory Performance of the Lifepreserver. There were three accidents in which either the lack of or performance of the life preservers was criticized:

- a. a Tracker that crashed into the sea after a bridal failure on takeoff from the aircraft carrier HMCS Bonaventure and the crew were run over by the ship (Case 8). One of the observers managed to inflate his life preserver, but only after two tries due to difficulty finding both toggles. With water rushing in through the overhead hatches and wet, slippery gloved hands, the two pilots were only able to find one toggle each, thus, with only one chamber inflated, giving about 8 lbs of buoyancy, they traversed the complete hull of the ship at 30 feet below the surface. Both were drawn into the vortex of the screws that propel the ship. Confronted with such extreme peril, they somehow managed to locate and inflate the second chamber of the life preserver which then returned them to the surface. One pilot's leg had been amputated by the propellers. This accident example should be enough to make every life preserver manufacturer insist that full life preserver buoyancy be provided with only one manual and/or automatic action. The disadvantages of this specific life preserver have been previously addressed (2).
- b. a Starfighter bird strike off Denmark (Case 50), in which the pilot ejected and hit the sea only five seconds after his parachute had opened. Initially he could not inflate his life preserver because he could not find the toggle. He went under water four or five times and made a concerted effort to release his parachute, boots and spurs. Finally, with extreme effort and desperation, he swam to the surface, where he had the presence of mind to lift up and look at the front of the life preserver to find and pull the toggle. If this pilot had not been a strong swimmer, he undoubtedly would have drowned;
- c. the Sea King crew trainer off the coast of Holland (Case 20). One life preserver did not inflate due to an unserviceable CO₂ cylinder; the life preservers of the other four crewmembers inflated satisfactorily.

Cases Where Lifepreservers Not Used. They were not used in 3 accidents (Cases 16, 21 and 30).

Failure of the Maritime Lanyard. Finally, there were four cases reported in this whole group in which the life preserver's maritime lanyard/dropline parted and the seat kit, raft and all survival contents were lost. This might have proven fatal for these survivors if rescue had not been so quick (Cases 41, 49, 50 and 53).

LIFE RAFT

Either a single-man or a 6-man life raft was available to aircrew in 28 of the accidents; it is not possible to deduce if rafts were carried in the other accident aircraft (Table 9). Of these 28 accidents, life rafts were inflated (or attempts were made to inflate them) in 17, lost in rapidly sinking aircraft in five, lost due to broken maritime lanyards in four and not used or needed in two (Sea King water take offs).

The rafts worked acceptably in 13 cases, although some adverse comments/complaints were made. Difficulty launching the 6-man raft occurred in two cases; and in one of these cases, the single-man life rafts were used by three crewmen while a fourth crewman's life raft did not inflate and he had to remain in 2.2°C sea water until rescue (he was rescued in only 10-15 minutes and probably would not have survived much longer in such cold water.) It is now a well known fact that in a rapidly flooding inverted Sea King helicopter it is virtually impossible to release the internal mounted 6-man life raft. Urgent consideration should be given to mounting such life rafts externally to the fuselage. Lack of floor insulation was cited in one case (which occurred before changeover to inflatable floors in 1978). And difficulty climbing into the life raft was also mentioned in one case.

Additional adverse comments about the life rafts were also made in four other cases. There were two jet accidents in which the single-man life raft only partially inflated and were described in the Inquiries as useless. There were no comments why they could not be orally or mechanically inflated once in the water. Presumably, they must not have been able to hold air due to massive leakage. These were, the Sabre accident off Norfolk, England, in which, following flame out, the pilot ejected and to make matters worse, also surfaced in the water entangled in his shroud line (Case 25) and, the second Starfighter accident off the air weapons range at Deccimomannu (Case 48). In one Sea King helicopter accident, five single-man life rafts inflated correctly but one did not inflate at all -- the aircraft rolled over on the 6-man life raft (Case 15). And there were insufficient rafts (and life preservers) in the Canso (Case 4).

The longest time spent in a life raft was 2 hours and 45 minutes.

OTHER LIFE SUPPORT EQUIPMENT

Survival equipment has not been used extensively because rescue times have generally been very short. There are very few comments in the boards of inquiry. Below are recorded both good and adverse statements by survivors:

a. Signalling Devices

(i) In 1953, the Sabre pilot who ejected into the North Sea off Cromer (Case 29) commented on how well the two star flares attracted a ship, that the sea marker worked well and that the mirror was seen by an aircraft;

(ii) the Mark VI flares were very easy to see in the night Tracker accident off Puerto Rico (Case 9);

(iii) the pencil flares worked well in the night Sea King accident off Bermuda, although the day-night flares only lasted 10 seconds (Case 18);

(iv) the flare gun was not easy to operate with a cold wet gloved hand in the Voodoo accident off the coast of Oregon and the PRQ501 rescue beacon performed poorly (Case 44);

(v) there was the unusual comment on the effect of a dye marker causing uveitis to the pilot in the Silver Star accident in Georgia Straits in 1958 (Case 41);

(vi) in the Sea King accident off Bermuda (Case 18), not all the rafts were fitted with radios; and

(vii) in the Sea King accident off Holland, three life preservers did not have signal flares, pencil flares, or strobe lights fitted (Case 20).

b. Other Miscellaneous Items

(i) in the Sea King accident above, the 6-man life raft did not have paddles;

(ii) in the Voodoo accident above, the zipper on the survival contents kit jammed and the way that it was packed was considered unhelpful to the survivor (i.e., the beacon, the first essential piece of equipment, was packed at the bottom with the socks and mitts on the top);

(iii) there was one case reported in which both the pilot and navigator of a Voodoo had difficulty operating the quick-release box on the parachute harness (Case 42) and in this same accident the navigator had difficulty in deploying his seat pack; and

(iv) Desalination tables have never been used and the lack of fresh water rations has not been a threat in any of the sea water immersions.

WATER SURVIVAL TRAINING

There were five accidents in which there were very positive comments made by survivors which illustrate the necessity and usefulness of water survival training: "wet dinghy drill extremely useful", "ten years of sea survival training paid off", "sea survival training made ejection and water survival easier", "good briefings on survival and escape drills helped", and "Dilbert Dunker and wet dinghy drills excellent in alleviating anxiety and stress of survival". The benefit of diving experience has also been well demonstrated by the Tracker observer who survived being run over by the aircraft carrier (Case 8). He was an experienced ship's diver and consequently was able to count the compartments as he passed under the hull and came up alongside the stern, unhurt and only mildly shaken! Similarly, a Sea King navigator, also an experienced diver, was able to make a conscious underwater escape from a severely damaged cabin, whereas three other crew members perished (Case 18).

SUMMARY OF FINDINGS

The observations listed below are made as a result of a thorough review of the records covering CF accidents involving sea water immersion during the 36-year period of 1 January 1952 to 31 December 1987:

- a. there have been a total of 55 such accidents;
- b. the survival rate has been 93 out of 161 (57%) personnel;
- c. there has been no apparent correlation between geographic location and either incidence of accidents or number of fatalities;
- d. there were eight night accidents, five were considered survivable and darkness is thought to have caused fatalities in three of these;
- e. rescue response has been very good;
- f. in 47 accidents (85%) the aircrew had less than 1 minute warning; there were 27 (58%) fatalities in these cases. Survivability is decreased when the warning time is less than 5 minutes;
- g. the F-86 Sabre now out of service had the greatest number of sea water accidents with 13 cases;
- h. aircrew operating the current in-service Sea King helicopter have the highest risk of sudden immersion in sea water;
- j. considering that primary life support equipment, such as life preservers, life rafts and immersion suits, should be reliable, there have been a number of failures;
- k. immersion suits were worn during only six of the 55 accidents and in two of these accidents were reported to have leaked;
- l. there were 5 cases in which the crew died probably due to a combination of cold, drowning and cardiac arrhythmias; none wore immersion suits;
- m. surviving crew were reported as cold in seven cases, including one in which a pilot suffered severe hypothermia and required active rewarming; in only one of these cases were immersion suits worn and they leaked badly; if rescue had not been quick, there would have been more fatalities;
- n. the need for and value of the Conax auto inflation valve on the life preserver has been confirmed; without it one airman would have undoubtedly perished;
- o. although the life preserver has saved the lives of several downed

airmen, the toggle of the life preserver manual activation device is difficult to locate and grasp; it contributed to one drowning, one serious injury and one near drowning;

- p. the life preserver maritime lanyard connected to the raft has been broken in four cases causing unacceptable loss of this equipment;
- q. the single-man life raft did not inflate in one case and only partially inflated in two cases;
- r. in a rapidly sinking inverted Sea King helicopter it is virtually impossible to deploy the 6-man life raft;
- s. the longest time spent in a life raft was 2 hours and 45 minutes; and
- t. underwater escape training, water survival training, swimming ability and diving experience have improved the chance of survival;

RECOMMENDATIONS

- a. Practical underwater escape training should be mandatory for all aircrew who regularly fly over water;
- b. Training in water survival should emphasize the fact that in the event of an accident (i) it is unlikely that the aircrew will have any warning, (ii) if it occurs at night, there is more potential for fatalities, and (iii) sea water accidents may be expected every 300,000 flying hours;
- c. The potential for hypothermia is ever present and all aircrew, during initial and refresher aeromedical training, must continue to be made aware of the hazards of ditching into cold water, the life saving actions that must be taken when immersed;
- d. NDHQ should (i) immediately redesign and replace the toggle of the life preserver manual activation device on all in-service life preservers, (ii) insist that full buoyancy of a life preserver be obtained by one manual and or automatic activation, (iii) review the quality control on the maintenance of immersion suits, life rafts and life preservers, and (iv) redesign the 6-man life rafts to be stowed on the external surface of the fuselage of maritime helicopters; and
- e. fund research into alternative methods of hypothermia protection to replace the standard ventile fabric immersion suit.

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REFERENCES

1. Brooks, C.J. and Rowe, K.W. Water survival: 20 years Canadian Forces experience. Aviat. Space and Environ. Med. 55(1): 44-51, 1984.
2. Brooks, C.J. and Firth, J.A. Review of the performance of the Canadian Forces military aircrew life preserver over the last 20 years. DCIEM Report No. 82-R-61, November 1982.
3. Canadian Forces Maritime Group Order 205.21.
4. Smiley, J.R. Survival and rescue experience RCAF ejections 1952-1963. RCAF Institute of Aviation Medicine, Technical Memorandum 64-TM-6, December 1964.

TABLE 1

NUMBER OF ACCIDENTS (N) INVOLVING SEA WATER IMMERSION
FROM 1952-1987
BY AIRCRAFT TYPE

<u>JET</u>	<u>N</u>	<u>PROPELLER</u>	<u>N</u>	<u>HELICOPTER</u>	<u>N</u>
F86 Sabre	13	CP121 Tracker	3	CH124 Sea King	10
CF104 Starfighter	8	Canso	2		
CF100 Canuck	4	CP107 Argus	2		
CF101 Voodoo	3	DC3 Dakota	2		
CT133 Silver Star	2	C45 Expeditior	1		
CT114 Tutor	1	Harvard	1		
CF5 Freedom Fighter	1	P51 Mustang	1		
CF18 Hornet	1				

TABLE 2

PROPELLER AIRCRAFT INVOLVING SEA WATER IMMERSIONS 1952-1987

CASE NO	A/C TYPE	DATE	NO. OF PERS		ACCIDENT SITE	CAUSE
			FATAL	NONFATAL		
1	Dakota 980	6 May 1952	6	--	Frobisher Bay, NWT	Struck ice floe in adverse weather
2	Dakota 985	28 Jan 1953	7	--	Georgia Sts, BC	Lost control in serious icing
3	Expeditor 1532	3 Feb 1954	--	5	Finale Fegure, Italy	Icing made radio compass u/s. Pilot lost, ran out of fuel
4	Canso 11073	24 Nov 1955	3	16	Knox Bay, Vancouver Island BC	Water looped in deteriorating weather
5	Canso 11041	30 Jun 1959	1	8	Prince Rupert, BC	A/C struck a floating sinker on landing on a mercy flight
6	Harvard 3062	14 Mar 1953	1	--	Westham Island, Vancouver Island BC	Lost control in low level tactics
7	Mustang 9566	19 Nov 1953	1	--	Sheldrake Island Miramichi Bay, NB	Disorientation target towing low level
8	Tracker 592	16 Feb 1969	--	4	West Indies off Puerto Rico	Bridle failure from carrier launch
9	Tracker 572	11 Mar 1969	--	4	Midway P. Rico & Jamaica	A/C struck parked A/C on carrier & unable to land back on
10	Tracker 175	19 Apr 1971	4	--	Sheet Harbour, NS	Suddenly disappeared into the sea. A/C never recovered.
11	Argus 727	12 Mar 1965	16	--	P. Rico West Indies	ASW mission, at low level, suddenly disappeared into sea. A/C never recovered.
12	Argus 717	24 Mar 1966	1	? no. of crew	Bay of Fundy, NB	Crewman went to inspect unsafe hatch indication and disappeared. Presume fell to death from photographic hatch

TABLE 3

HELICOPTERS INVOLVING SEA WATER IMMERSIONS 1952-1987

CASE NO	A/C TYPE	DATE	NO OF PERS		ACCIDENT SITE	CAUSE
			FATAL	NONFATAL		
13	Sea King 019	22 Mar 1967	1	3	18 m S of Halifax, NS	Crewman fell to death from cargo door
14	Sea King 002	1 Dec 1967	2	2	NE of Bermuda	Disorientation
15	Sea King 427	22 Feb 1968	--	6	W of Dominica West Indies	Mechanical problems
16	Sea King 407	15 Jun 1968	--	4	Off New York	Engine problem, planned ditching and takeoff
17	Sea King 015	24 Jun 1969	--	5	Off Bermuda	Engine problems and human factors
18	Sea King 420	7 Nov 1971	3	1	300 m SE Halifax, NS	Likely disorientation
19	Sea King 418	24 Oct 1973	--	4	30 m SE Halifax, NS	Mechanical problems
20	Sea King 423	24 Jun 1974	--	5	Off Holland, North Sea	Engine problem
21	Sea King 439	16 Oct 1980	--	4	45 m E Halifax, NS	Engine problem, planned ditching and water takeoff
22	Sea King 409	4 Nov 1987	--	3	20 m S Halifax, NS	Emergency chiplight. Planned ditching

TABLE 4

JET AIRCRAFT INVOLVING SEA WATER IMMERSIONS 1952-1987

CASE NO	A/C TYPE	DATE	NO OF PERS		ACCIDENT SITE	CAUSE
			FATAL	NONFATAL		
23	Sabre 19181	Apr 1952	1	--	North Sea	Midair collision at 8000 ft. Ejected
24	Sabre 19187	1 Jul 1952	1	--	Flamborough Head Yorks, North Sea	Fuel exhaustion, crashed into sea
25	Sabre 19112	8 Jul 1952	--	1	Hunstanton, Norfolk, North Sea	Flame out, loss of electric and boost control at 7500 ft. Ejected.
26	Sabre 19281	29 Sep 1952	1	--	Neguac Beach, Gulf of St. Lawrence	Air to air firing, contacted drogue & spiral dived into sea
27	Sabre 19326	17 Mar 1953	1	--	Miramichi Bay, NB	Two plane training flight. Lead compass became unreliable at 4000 ft. On approach both crews became disoriented & crashed into sea.
28	Sabre	17 Mar 1953	1	--		
29	Sabre 19158	30 Aug 1953	--	1	Cromer, Norfolk, North Sea	Fuel exhaustion, ejected
30	Sabre 19152	26 Nov 1953	--	1	Wells, Norfolk, North Sea	Loss of control ejected at 7000 ft
31	Sabre 19442	1 Dec 1953	1	--	Miramichi Bay, NB	Loss of control and fuel exhaustion. Ejected.
32	Sabre 19400	3 May 1954	1	--	Miramichi Bay, NB	Low level airshow practice. Possible mechanical failure & crashed into sea
33	Sabre 23193	2 Feb 1955	--	1	Valencia, Spain Atlantic Ocean	Engine fire at 6000 ft. Ejected
34	Sabre 23229	14 Apr 1960	1	--	Miramichi Bay, NB	Engine problem. Ejected

TABLE 4 cont'd

CASE NO	A/C TYPE	DATE	NO OF PERS		ACCIDENT SITE	CAUSE
			FATAL	NONFATAL		
35	Sabre 23304	27 Jul 1967	1	--	Tracadie, NB	Unrecoverable spin during full card air test at 15,000 ft. Ejected.
36	Canuck	May 1956	--	1	Georgia Sts off Comox, BC	Engine failure. Ejected.
37	Canuck 18499	16 Dec 1958	1	1	Campbell River, BC	Double engine failure at 20,000 ft. Ejected
38	Canuck 18682	19 Jan 1960	2	--	Georgia Sts, BC	Disorientation on approach into Comox, crashed into sea.
39	Canuck 18513	21 Jul 1965	2	--	100 m W Harmon AFB, Nfld	Possibly misread altimeter & crashed into sea
40	Silver Star 21361	22 Feb 1957	1	--	Off Vancouver, BC	Mis-set altimeter and crashed into sea
41	Silver Star 21067	6 Sep 1958	--	2	Georgia Sts, BC	Midair collision, one A/C landed. The other crew ejected.
42	Voodoo 440	18 Feb 1971	--	2	Georgia Sts, BC	Engine problems
43	Voodoo 061	5 Jul 1976	2	--	Georgia Sts, BC	Undetermined, likely human factors
44	Voodoo 018	29 Nov 1979	--	2	Portland, Oregon	Pitch up. Ejected
45	Tutor 082 and 088	16 Jul 1977	--	2	Seattle, Washington	Midair collision. Both pilots ejected into sea. One A/C landed
46	Star-fighter 802	23 Jul 1963	1	--	Deccimomannu, Sardinia	Low level radar bomb drop crashed into sea
47	Star-fighter 879	16 May 1965	1	--	Stranraer, Irish Sea	Radar test flight. A/C suddenly disappeared into sea

TABLE 4 cont'd

CASE NO	A/C TYPE	DATE	NO OF PERS		ACCIDENT SITE	CAUSE
			FATAL	NONFATAL		
48	Star-fighter 817	5 Jul 1965	--	1	Deccimomannu, Sardinia	Ejected
49	Star-fighter 738	13 Aug 1965	--	1	Deccimomannu, Sardinia	Engine failure. Ejected.
50	Star-fighter 734	18 Jul 1967	--	1	Aalborg, Denmark	Low level bird strike and ejected
51	Star-fighter 791	11 Sep 1967	1	--	Vliehors Range, Holland	Disorientation during bombing exercise
52	Star-fighter 864	10 May 1973	1	--	Bodo, Norway	Air combat manoeuvre. Pitched up & ejected out of envelope
53	Star-fighter 859	27 Aug 1980	--	1	Terschelling Range, Holland	Ejected at 450 knots & hit water simultaneously with parachute opening
54	Freedom Fighter 720	12 Nov 1987	--	1	Gulf of Mexico	Unable to recover from a spin. Ejected
55	Hornet 717	24 May 1986	1	--	Malpeque Bay, PEI	Undetermined

TABLE 5

A COMPARISON OF HOW MANY FATAL AND NON-FATAL ACCIDENTS
THERE WERE IN EACH PRINCIPAL TYPE OF AIRCRAFT

	ALL FATAL	FATAL/NON-FATAL	ALL NON-FATAL
PROPELLER	6	3	3
HELICOPTER	---	3	7
JET	18	1	14

TABLE 6

GENERAL SURVIVAL INFORMATION

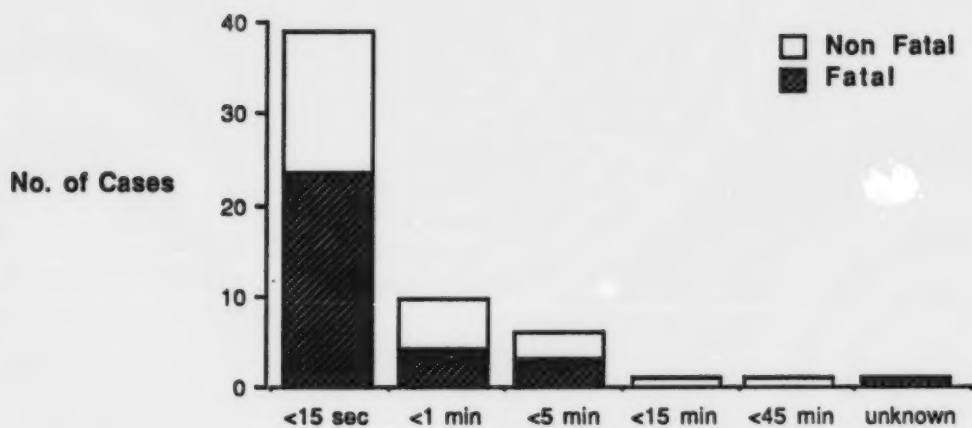
CASE NO	WARNING TIME	F OR NF	TIME TO RESCUE	METHOD OF RESCUE	NIGHT ACCIDENT	WATER TEMP °C
1	Under 15 sec	F	----	-----	Night	
2	Under 2 min	F	----	-----		
3	10-15 min	NF				
4	?	F/NF				
5	Under 2 min	F/NF	Very rapid			
6	Under 15 sec	F	----	-----		
7	Under 15 sec	F	----	-----		
8	Under 15 sec	NF	5-10 mins	Helicopter		26.7
9	40 min	NF	5-8 mins	Boat	Night	22.7
10	Under 15 sec	F	----	-----		2.2
11	Under 15 sec	F	----	-----	Night	
12	Under 15 sec	F/NF	----	-----		
13	Under 15 sec	F/NF	----	-----		0.0
14	Under 15 sec	F/NF	45 min	Boat	Night	21.1
15	Under 15 sec	NF	15-20 min	Submarine		25.9
16	Under 15 sec	NF	Water take off	Water take off		
17	Under 15 sec	NF	2 hr 45 min	Boat		
18	Under 15 sec	F/NF	10 min	Boat	Night	21.1
19	Under 15 sec	NF	10-15 min	Helicopter		2.2
20	Under 15 sec	NF	5-6 min	Boat		13-15
21	Under 15 sec	NF	Water take off	Water take off		12.0
22	2-3 min	NF	20 min	Helicopter		11.0
23	Under 15 sec	F	----	-----		

TABLE 6 cont'd

CASE NO	WARNING TIME	F OR NF	TIME TO RESCUE	METHOD OF RESCUE	NIGHT ACCIDENT	WATER TEMP °C
24	Under 15 sec	F	----	----		
25	Under 1 min	NF	Very quick	Boat		
26	Under 15 sec	F	----	----		
27	Under 15 sec	F	----	----		
28	Under 15 sec	F	----	----		
29	Under 1 min	NF	45 min	Boat		
30	Under 1 min	NF	?	Walked ashore		
31	Under 1 min	F	----	----		
32	Under 15 sec	F	----	----		
33	Under 5 min	NF	?	?		7.0
34	Under 1 min	F	----	----		
35	Under 2 min	F	----	----		
36	Under 1 min	NF	?	?		
37	Under 1 min	F/NF	2 hours	Boat	Night	
38	Under 15 sec	F	----	----	Night	
39	Under 1 min	F	----	----		
40	Under 15 sec	F	----	----	Night	
41	Under 15 sec	NF	30 min	Boat		
42	Under 15 sec	NF	5-10 min	Helicopter		
43	Under 15 sec	F	----	----		
44	Under 1 min	NF	90 min	Helicopter		12.5
45	Under 15 sec	NF	5 min	Boat		15.0
46	Under 15 sec	F	----	----		

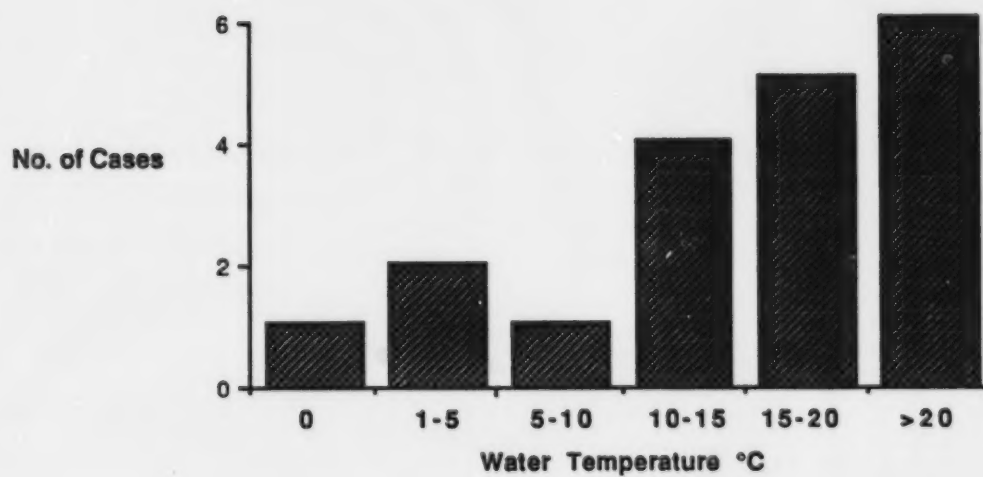
TABLE 6 cont'd

CASE NO	WARNING TIME	F OR NF	TIME TO RESCUE	METHOD OF RESCUE	NIGHT ACCIDENT	WATER TEMP °C
47	Under 15 sec	F	----	----		
48	Under 15 sec	NF	15 min	Helicopter		26.6
49	Under 15 sec	NF	10 min	Boat		15.5
50	Under 15 sec	NF	23 min	Helicopter		16.0
51	Under 15 sec	F	----	----		17.0
52	Under 15 sec	F	----	----		
53	Under 15 sec	NF	5 min	Helicopter		18.0
54	Under 15 Sec	NF	90 mins	Helicopter		
55	Under 15 sec	F	----	----		



WARNING TIMES IN ALL 55 SEA WATER ACCIDENTS

TABLE 7



NO. OF ACCIDENT CASES IN WHICH WATER TEMPERATURES WERE REPORTED

TABLE 8

TABLE 9

GENERAL DETAILS OF LIFE SUPPORT EQUIPMENT
REPORTED IN 55 SEA WATER ACCIDENTS

CASE NO	PHYSIO SYMPTOMS	IMMERSION SUITS	LIFE PRESERVERS	LIFE RAFTS
1		NO		
2		NO		
3		NO		
4		NO	Insufficient & lack of knowledge of operation	Insufficient & lack of knowledge of operation
5		NO		
6		NO		
7		NO	Lost	Lost
8	Leg amputation by ship prop	NO	Serious toggle problems. Injured as result	Lost
9		NO	Inflated OK	6-man OK
10				
11		NO	Lost	Lost
12		NO		
13		Yes, lost in accident	Lost	
14		NO	Inflated OK	2 singles OK
15		NO	Inflated OK	5 out of 6 singles OK, 6-man rolled on by A/C
16		NO	Not used	Not used
17		NO	Inflated OK	6-man and 2 singles OK

TABLE 9 cont'd

CASE NO	PHYSIO SYMPTOMS	IMMERSION SUITS	LIFE PRESERVERS	LIFE RAFTS
18	all cold	NO	Inflated OK for the 1 survivor	Lost in A/C
19	all cold	YES, all leaked badly	All inflated OK	3 singles OK unable to launch 6-man
20		YES, OK. 1 PAX not wearing one	3 inflated OK, 1 did not. No flares	Difficult to launch 6-man raft
21		YES, not used	Not used	Not used
22		YES, 1 suit leaked	Inflated OK	6-man raft OK
23	died from exposure in cold water			
24		NO		
25	Too tired & cold to assist	NO	Inflated OK	Only inflated 10%
26		NO		
27		NO		
28		NO		
29		NO	Inflated OK, difficulty climbing into raft	Inflated OK
30		NO	Not used	
31	died from skull fracture, drowning & cold, found 8 days later	NO	Inflated OK but drowned	

TABLE 9 cont'd

CASE NO	PHYSIO SYMPTOMS	IMMERSION SUITS	LIFE PRESERVERS	LIFE RAFTS
32		NO		
33		NO	Presume inflated OK	
34	died simple exposure	NO	Inflated OK but drowned	
35	Died from skull fracture, likely drowned & cold	NO	Lost, didn't inflate probably drowned, no AID	
36		NO	Inflated OK	Inflated OK
37	Navigator likely drowned & cold. Pilot cold and injured in rescue	NO	Inflated OK	Inflated OK
38		NO		
39		NO		
40		NO		
41	Pilot suffered mild shock	NO	Both inflated OK	Lost, lanyard parted
42		NO	Inflated OK, toggle problem	Inflated OK
43		NO	1 lost, 1 found serviceable	
44	both cold	NO	Both inflated OK, well worn	Inflated OK
45		NO	Inflated OK, AID worked well	Inflated OK (single floor)
46		NO		
47		NO		

TABLE 9 cont'd

CASE NO	PHYSIO SYMPTOMS	IMMERSION SUITS	LIFE PRESERVERS	LIFE RAFTS
48	Severe, required rewarming	NO	Inflated OK	Partial inflation
49		NO	Inflated OK, nearly drowned	Lost, lanyard parted
50		NO	Didn't inflate OK, toggle problem, nearly drowned	Lost, lanyard parted
51				
52		YES	YES, no comments in Board of Inquiry	
53	Cold	NO	Inflated OK, AID worked well	Lost, lanyard parted
54		NO	Inflated OK	OK
55		NO	Lost	Lost